Implementations of Autonomous Maintenance to Relieve Stoppages on PT NIKF – Sachet Packaging Chain

Sukanta[1], R Maulana[1], Dessy Agustina Sari[2]

***Abstract*— Autonomous maintenance taught operator to keep devices, create cooperation each employer and did problem solving that occurring in machine. This research described assembling of autonomous maintenance on PT NIKF – minor stoppages trouble in sachet production line. Our team used the OEE method to know the latest line condition and variety losses that causing the performance were not optimal. After that, the next steps were using visual losses map and diagram Pareto to get the detail (component with many losses). By Go See Think Do, the researcher could find much maintenance that must be done in SIC line 1. Through the application, this effort could reduce the losses of minor stoppages - 79,52%.**

Keywords—Minor stoppages, go see think do.

I. Introduction

Maintenance goal in device aspect of manufacture industry was improvement effectiveness or optimality of equipment or machine. In reality, effort for the repairing was often an only wasting because it did not relate the main set of problems. Team for this did not get clearly plus truth of the trouble and factor agents. In Infant Cereal Plant, sachet line of Chain 1 (SIC line 1) still was found some question such as high percentage of engine damage (breakdown and or minor stoppages). This happen caused uncomplete the company target and Figure 1 showed that asset intensity of SIC line 1 in 2016 was still acceptable. It was one of many key performance indicators (KPI) in PT NIKF that indicating capability a machine or line to do production process.

The figure also defined that the factory might make definition and new concept from their upgrading system. The both things were not only able to enactive belong equipment (produce Good Finish) but also it could too measure globally efficiency, matter identify, and give improvement idea that might be done. Through that, autonomous maintenance (AM) design could be a solution in this company. AM was part of Total Productivity Maintenance (TPM) program. This method also used Global Trans Energy Global to get information all of condition and reduce waiting time to increase operational effectiveness in ship (fleet)[1].

So on implementation, it included many sides – production sectors. Researcher (Singh, Gohil, Shah, & Desai, 2013) statement that success of TPM depended on 5-S, Jishu Hozen, planned maintenance, quality maintenance, Kaizen, office TPM and safety, health and environment. One of the purposes was to increase knowledge and skill about production. Then, machine treatment for employer would too give positive affect.

II. Method

Methodology that used this research was resumed in Figure 2.

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III. Results and Discussion

A. Measuring of Overall Equipment Effectiveness

The OEE point could show the latest situation in SIC line 1 and performance all of the equipment that losing could be pushed. This way also acted as image performance from day to day and as tools in continuous improvement program for manufacturing industry [2] and supported by supply of necessary resources [3]. Data that given was weekly outlet OEE on 1st until 31st - 2016 years, see Figure 3 – 6. This research gave estimation of availability, performance, and quality ratio with each its formula.

B. Availability Ratio (AR)

$$\text{Availability Ratio} = \frac{\text{Operating Time}}{\text{Loading Time}} \times 100\%$$

$$AR = \frac{\text{Loading Time} - \text{Unplanned Stoppages}}{\text{Production Time} - \text{Planned Stoppages}}$$

$$\text{AR} = \frac{(6997{,}2\ - 1490{,}4)\ \text{minutes}}{(7680 - 682{,}8)\ \text{minutes}} \times 100\%$$

$$\text{AR} = \frac{5506{,}8}{6997{,}2} \times 100\% \sim 78{,}70\%$$

C. Performance Ratio (PR)

Cycle time was time that needed to produce one card board box (CB) and the research was based on field data. Sachet product that resulted each minute was 50 items. Every CB was consist of 16 slender so it that outcome per minute was 3,125 (50 per 16) and percentage of performance ratio in first week was this below.

$$\text{PR} = \frac{\text{Output} \times \text{Cycle Time}}{\text{Operating Time}} \times 100\%$$

$$\text{PR} = \frac{17.117 \times 1\ \text{minute}}{3{,}125\ \text{CB} \times 5506{,}8} \times 100\%$$

$$\text{PR} = 99{,}47\%$$

C. Quality Ratio

$$\text{Quality Ratio} = \frac{\text{Output} - \text{Total Defect}}{\text{Output}} \times 100\%$$

$$\text{Quality Ratio} = \frac{(17.117\ - 77{,}75)\ \text{CB}}{(17.117)\ \text{CB}} \times 100\%$$

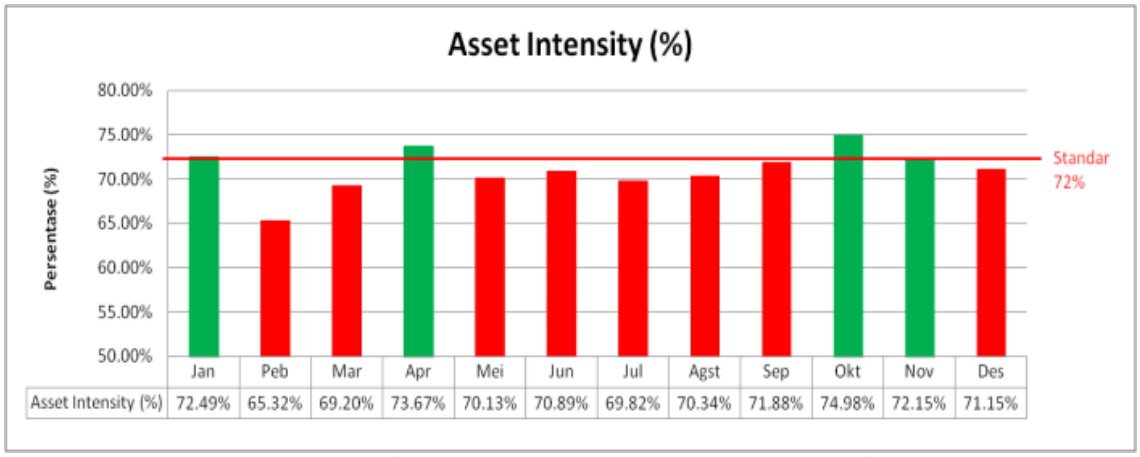

Figure 1. Achievement of asset intensity in SIC line 1 (source by annual report of PT NIKF).

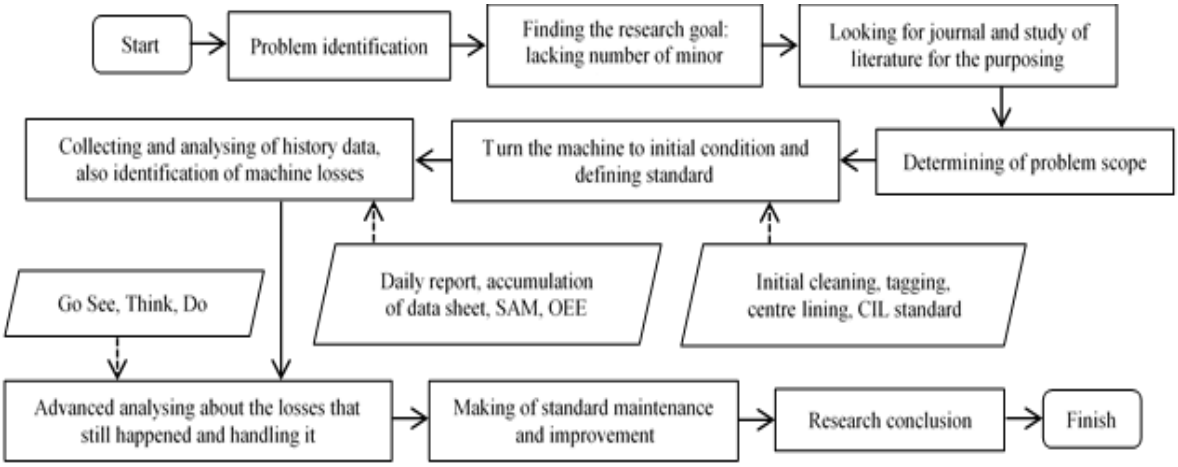

Figure 2. Flowchart of research method.

Figure 3. Trend of availability ratio point

$$\text{Quality Ratio} = 99{,}55\%$$

After that, accounting of OEE used this equation

$$\text{OEE} = \text{Availability Ratio} \times \text{Performance Ratio} \times \text{Quality Ratio}$$

$$\text{OEE} = 78{,}70\% \times 99{,}47\% \times 99{,}55\%$$

$$\text{OEE} = 77{,}92\%$$

Achievement of OEE in SIC line 1 still often did not reach the standard score. The world class manufacturing OEE was 85% [4]. By the estimation, low of availability point was failure – 78,70%. It should be 90%. Highly unplanned stoppages were 21.9333,93 minutes for 31st and 1.668 minutes in last week. The both of reasons also supported the existing trouble. So, the researchers would fix the effectiveness of machine by reducing amount of unplanned stoppages. Another researcher gave a statement that the OEE tool could help to optimize the performance of existing capacity [5]. OEE score 63-79% indicated that experiment had improvement in productivity and quality of product [3].

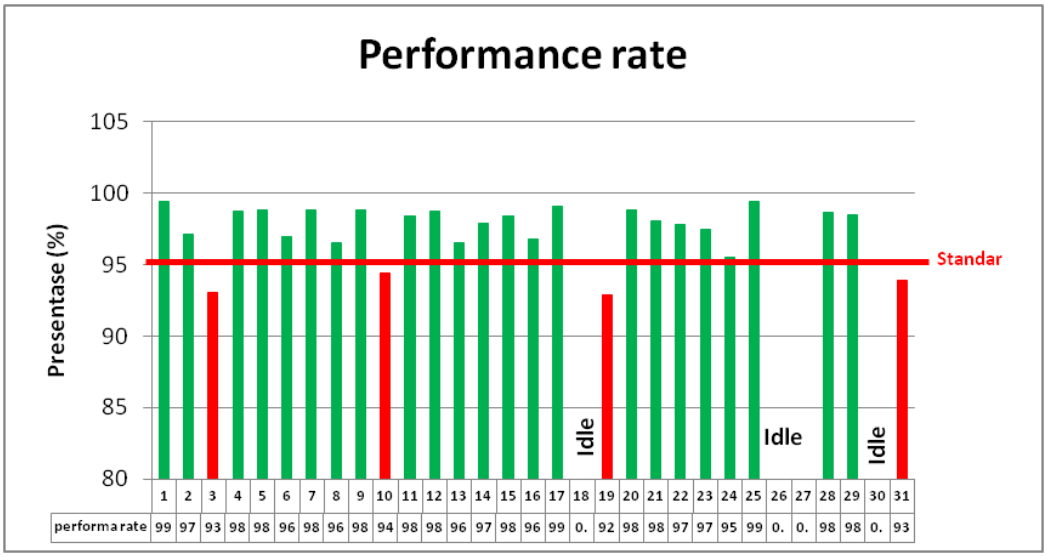

Figure 4. Preference of performance rate.

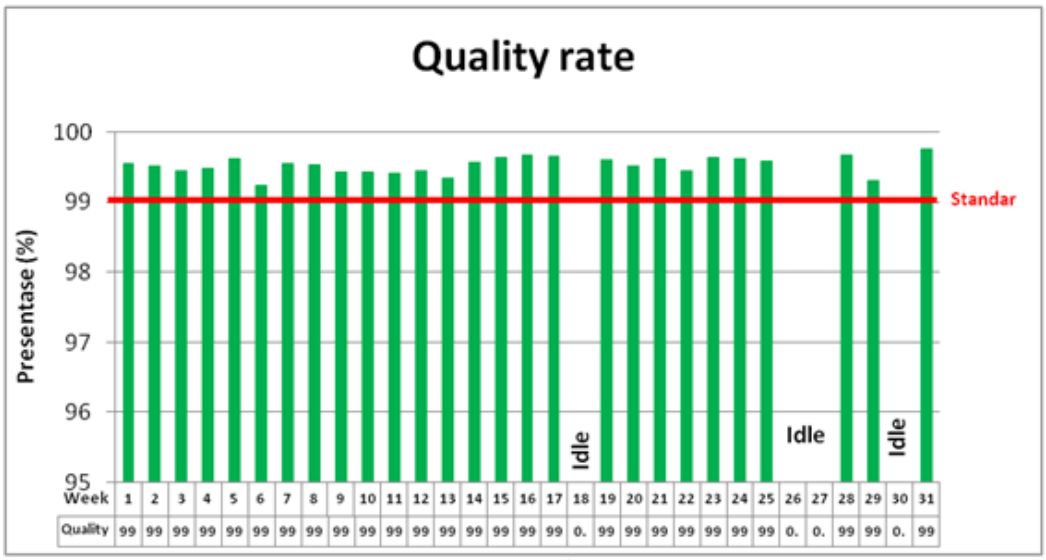

Figure 5. Inclination of quality ratio.

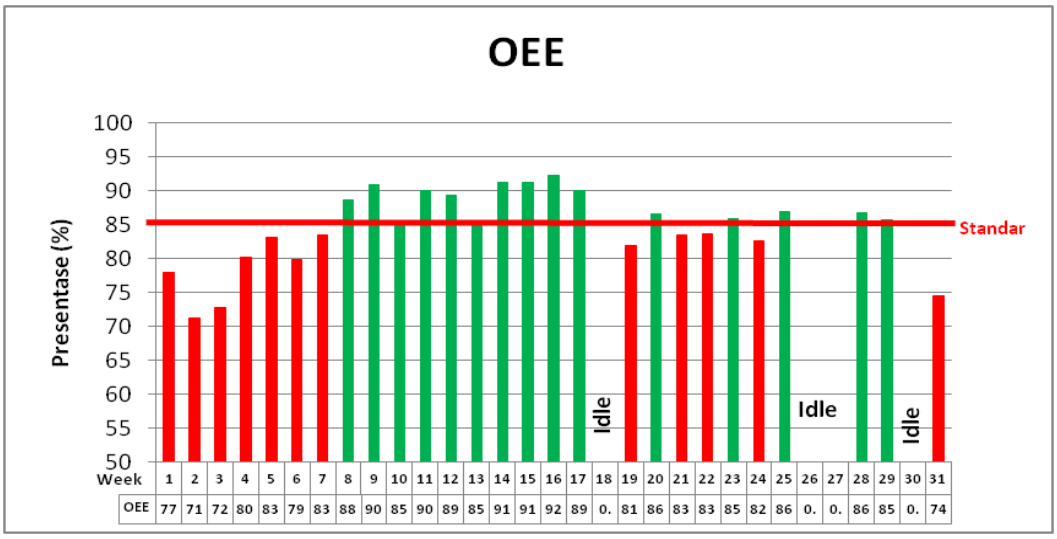

Figure 6. Trend of OEE score.

D. Time and Venue Stoppages

The researchers used Visual Loss Mapp to guide where and how long stoppages. Data that needed was stoppages data from SAM software for 3 months (May – July, 17th to 31st week, see Figure 7 below). The image explained that the biggest problem was minor stoppages in packing area such as sachet jammed in 2nd formation unit (2059 minutes, 624 times) and 1st was 1619 minutes, 506 times. Next, in 1st and 2nd folding unit were 465,85 -- 265 and 266,85 minutes --198 times consecutively.

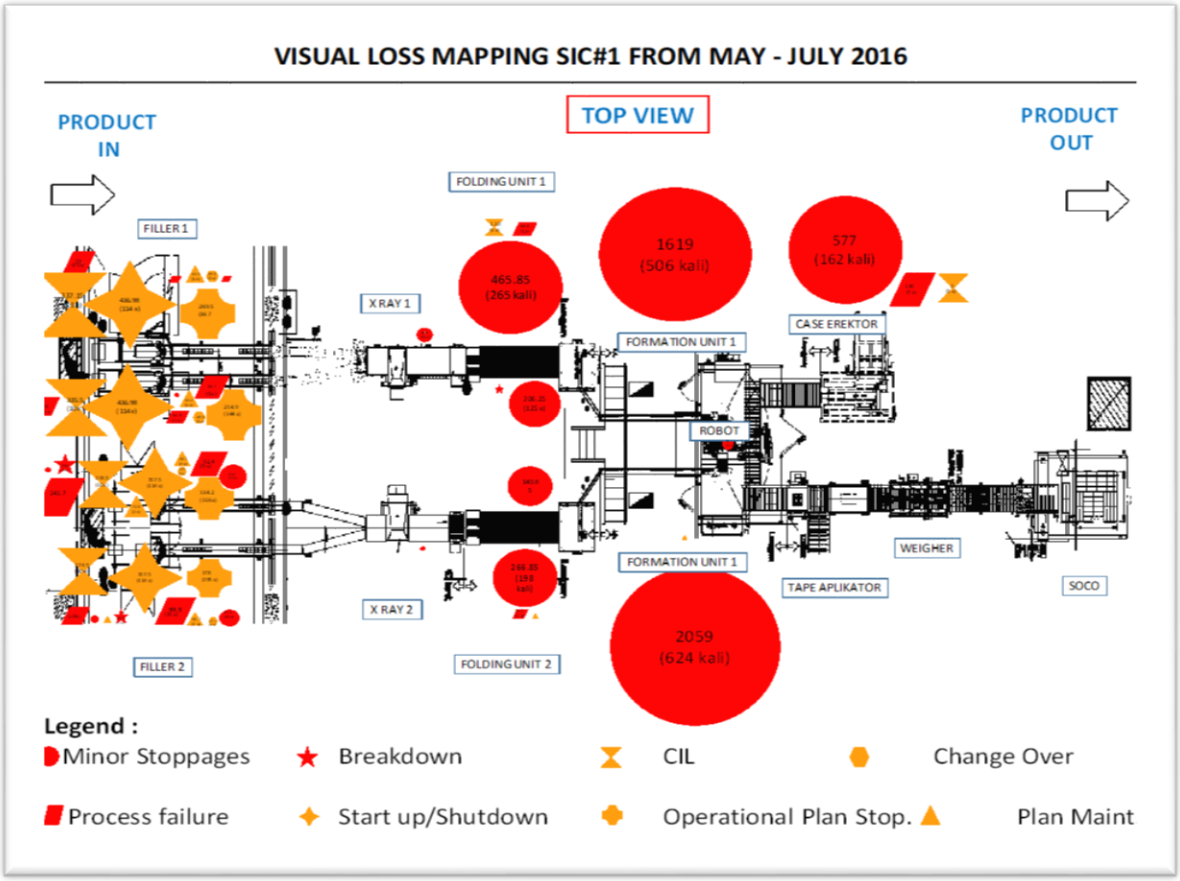

Figure 7. Outlet visual loss map in SIC line 1 in May – July
(Source: stoppages analysis modulus – SAM in SIC line 1).

Based on Figure 7, the researcher pulled the data in 31st week to know the newest condition in SIC line 1. Pareto diagram was given in Figure 8 to review and understand minor stoppages in last time.

Figure 8 showed that two machine component that donating higher minor stoppages was 1st and 2nd formation unit, 64% and 29,72% in Folding 1&2 Unit. So high condition (almost 93,78%) could be certain that the both tools got improvement. Analysing to the component utilized Go See Think Do (GSTD) way to find out the question source and then fixing treatment.

E. Presence Analysis of Minor Stoppages

Next way was to handle the existed problem that found out from the processing data. It was minor stoppages that still being present in component of formation and folding unit – jammed sachet. The best treatment exploited an instrument. It was Go See Think Do (GSTD) that usually utilized to break the daily matter. GSTD could help user to get the trouble source that be on going (Gemba) and resumed in Table 1-3 and Figure 9 for the Formation 1 and 2 Unit), and Table 4-6 and Figure 10 for the Folding 1 and 2 Unit.

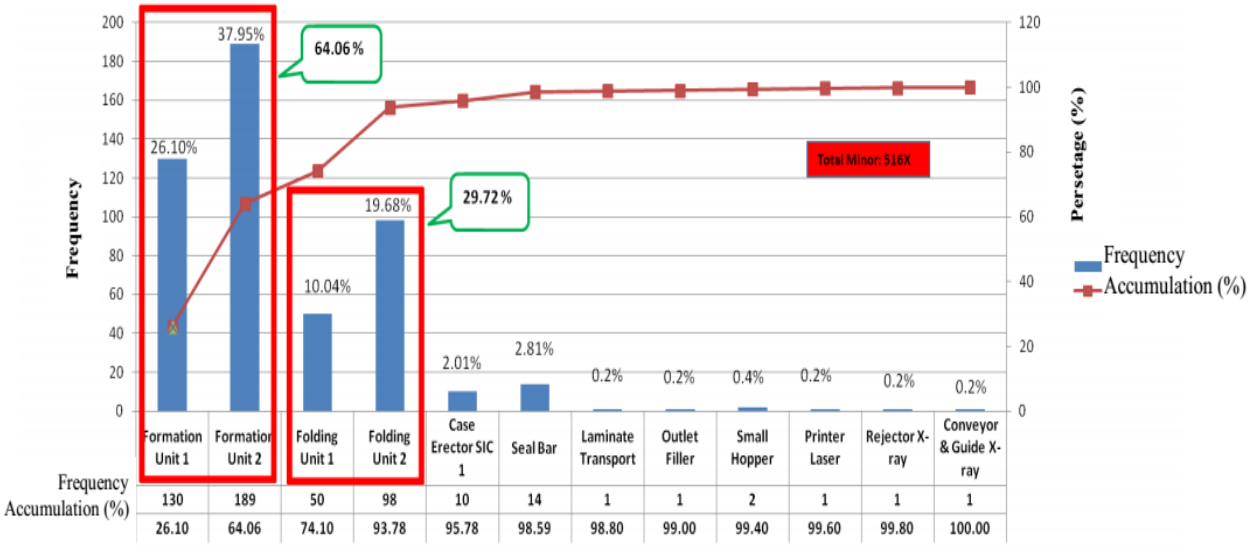

Figure 8. Pareto diagram of minor stoppages in SIC line 1 – 31st week.

F. GSTD to Minor Stoppages on Formation 1 and 2 Unit

1. Go See

TABLE 1.
GO SEE TO MINOR STOPPAGES IN FORMATION 1 AND 2 UNIT

Focus on the problem (4W1H)					
WHAT	Problem of sachet jammed				
WHERE	Formation 1 and 2 Unit	**WHO**	ACF Operator		
WHEN	31st Week	**HOW MUCH/MANY**	319 times with 614 as duration		
Check Points Y (Yes), N (No), N/A was not available for the check box		What was the action? If the answer was NO and valid, write the action, who, when and status		Who	When	Status
Y	What was the standard exist? (If yes, go to next question, if not so move to Think Do phase)	Puffing of sachet checking was determined (9-10 mm/8 sachets) (NO OPL : 0616-IC5-180) and auto machine operation of chain folding (6761.16.W.047-0)		Elyina	15th Week	Done
Y	What did the standard follow? (If yes, go to Think Do phase, if not so go to the next point	Checking was done every 30 minutes by operator ACF (NO OPL : 0616-IC5-180)		ACF Operator	15th Week	Done
Y	Have the worker trained by this standard?	Share one point lesson (OPL) to operator ACF (NO OPL : 0616-IC5-180)		Septian	July 20th	Done
Y	Was the standard easy to understand?	OPL was given with the pictures for easy learning and directly practice		Septian	July 20th	Done
Y	Was the parameter or equipment suitable into specification?	Jig tools of puff checking was suitable standard and fulfil scale to simplify the checking		Cosmas	15th Week	Done

2. Think

After founded the existed problem and standard investigation still happened so next ways was looking for the cause by thinking point. It was done through group – brainstorming to get possible cause. In this stage, the researcher used device – fishbone and 5WHY analysis (Figure 9 and Table 2). Figure 9 showed that the matters were J, L, M, and N.

A = case did not open, B = soon vacuum in robot was hard, C = parameter of stopper plate had changed, D = puffing device was not calibrated, E = conveyor installation of formation unit was wrong, F = how to pair magazine case was wrong, G = standard cleaning was not exist yet, H = area of formation unit was slippery, I = area of formation unit was dirty, J = sensor did not detect sachet, K = loss vacuum in robot, L = tip of the sachet stuck in finger pusher, M = end of the sachet stuck in sensor hole, N = sachet left in separation unit, O = new operator, P = skill operator.

3. Do

After Go See and Think, the last step was implementation by the stakeholders. They had given the job to do section. The action was served in Table 3.

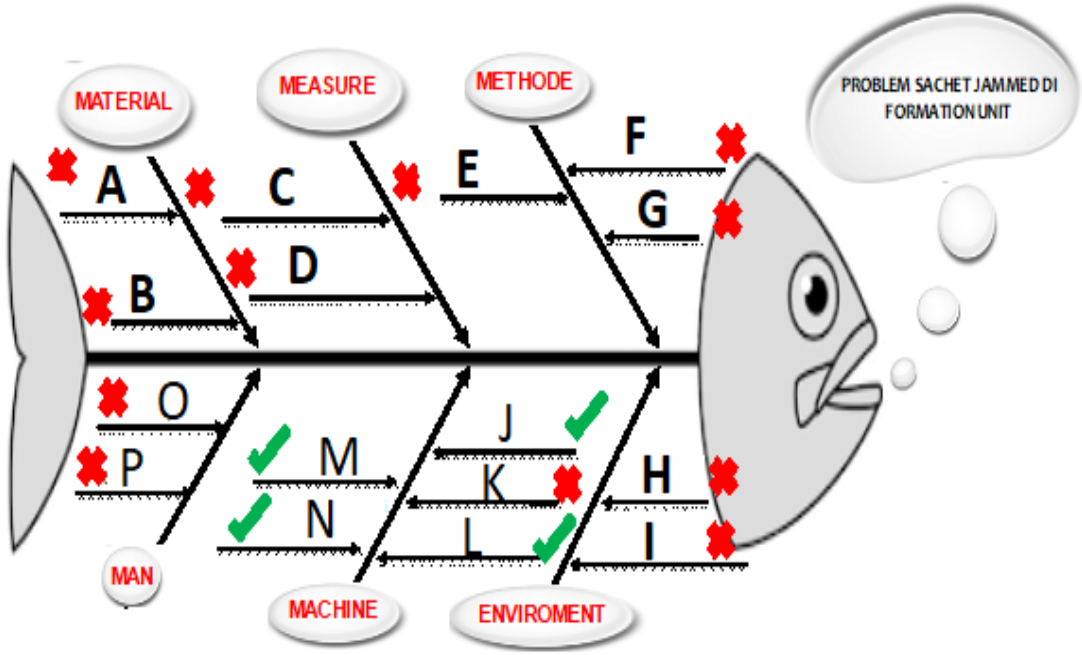

Figure 9. Fishbone of sachet jammed in formation unit through Think step.

TABLE II
5WHY ANALYSIS OF MINOR STOPPAGES IN FORMATION 1 AND 2 UNIT – THINK STAGE

5 Why Analysis											
1. Start by asking WHY, answer						3. Circle the verified root causes					
2. Write	If the cause is confirmed at Gemba		No	If the cause was not confirmed				4. Mark each root cause with a.1,2,… to link action afterwards			
A/Q	Possible Causes	Why?	Y/N	Why?	Y/N	Why?	Y/N	Why?	Y/N	Why?	Y/N
Question Answer	Sachet left in separation unit	Because sachet often stuck in tip of guide separation	Yes	Because in front of clamp was wider than clamp separation	Yes	Because the space between separation and clamp was existed standard yet	Yes	Because guide separation was changed variable	Yes	Because center lining was existed in area clamp yet (root cause 1)	
Question Answer	Sachet stuck in finger pusher	Because the tip of sachet was out from slide guide	Yes	Because gap between slide guide and conveyor was so higher	Yes	Original of the machine fabrication (root cause 2)					
Question Answer	Sachet stuck in sensor holes	Because the sachet was slippery in tip of sensor	Yes	Hole part of sensor was in sachet line	Yes	Because initial standard was sensor position (root cause 3)					
Question	The sensor did not detect the sachet	Because sensing red light on the sensor did not touch sachet	Yes	Sensing area to sachet tighten	Yes	Because sensing's sensor was only gone to one point	Yes	Because sensor used dot type (point) (root cause 4)			

TABLE III
ACTION LIST FROM CAUSE ROOTS OF MINOR STOPPAGES IN FORMATION 1 AND 2 UNIT

Root Causes	**Action List**	**Who**
RC 1	Installation centre lining in separation unit 1 and 2	Ropikin
RC 2	Modification of the gap slide guide from 12 to 5 mm	Afipudin
RC 3	Close the sensor hole on first product and reposition of the sensor	Afipudin
RC 4	Sensor replacement from type of sensing dot type to horizontal	Handi Koswara

G. GSTD to Minor Stoppages on Folding 1 and 2 Unit

1. Go See

TABLE IV
GO SEE TO MINOR STOPPAGES IN FOLDING 1 AND 2 UNITS

Focus on the problem (4W1H)

WHAT Problem of sachet jammed

WHERE Folding 1 and 2 Unit

WHO ACF Operator

WHEN 31st Week

HOW MUCH/MANY 148 times

Problem statement (using 4W1H)
Problem sachet jammed on Folding 1&2 Unit until 31st week by ACF operator got 148 times

Check Points Y (Yes), N (No), N/A was not available for the check box		What was the action? If the answer was NO and valid, write the action, who, when and status	Who	When	Status
Y	What was the standard exist? (If yes, go to next question, if not so move to Think Do phase)	Puffing of sachet checking was determined (9-10 mm/8 sachets) (NO OPL : 0616-IC5-180) and auto machine operation of chain folding (6761.16.W.047-0)	Elyina	15th Week	Done
Y	What did the standard follow? (If yes, go to Think Do phase, if not so go to the next point	Checking was done every 30 minutes by operator ACF (NO OPL : 0616-IC5-180)	ACF Operator	15th Week	Done
Y	Have the worker trained by this standard?	Share one point lesson (OPL) to operator ACF (NO OPL : 0616-IC5-180)	Septian	July 20th	Done
Y	Was the standard easy to understand?	OPL was given with the pictures for easy learning and directly practice	Septian	July 20th	Done
Y	Was the parameter or equipment suitable into specification?	Jig tools of puff checking was suitable standard and fulfil scale to simplify the checking	Cosmas	15th Week	Done

2. Think

Figure 10 showed that two point of possible of root cause were K and L. Then, the problems were analyzed by 5WHY to know the truth matters in minor stoppages in folding 1&2 units. Table 5 gave data of the root causes in folding.

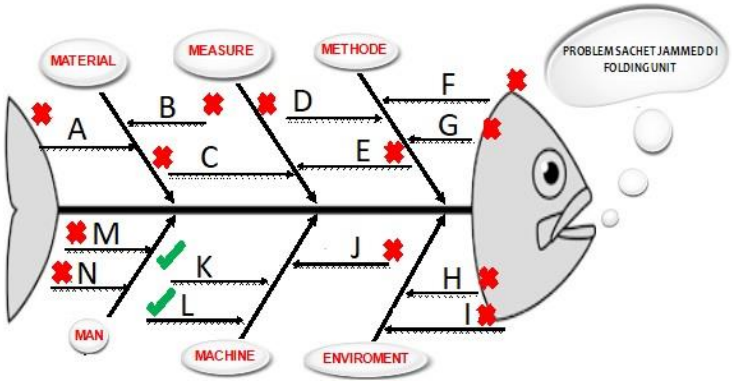

Figure 10. Fishbone of sachet jammed in folding unit through Think step.

A = laminate was rigid and shiny, B = sachet puffing was not standard, C = puffing device was not calibrated, D = installation of conveyor folding was wrong, E = parameter of folding unit had changed, F = puff checking had difference, G = cleaning standard was not existed yet, H = are of folding unit was slippery, I = area of folding unit was dirty, J = the sensor did not detect sachet, K = sachet stuck in drop plate, L = failure in folding process, M = new operator, N = skill operator.

TABLE V
5WHY ANALYSIS OF MINOR STOPPAGES IN FOLDING 1 AND 2 UNIT – THINK STAGE

5 Why Analysis											
1. Start by asking WHY, answer 2. Write	If the cause is confirmed at Gemba		No	If the cause was not confirmed		3. Circle the verified root causes		4. Mark each root cause with a.1,2,… to link action afterwards			
A/Q	Possible Causes	Why?	Y/N	Why?	Y/N	Why?	Y/N	Why?	Y/N	Why?	Y/N
Question											
	Failure on folding process	Sealing horizontal was rigid	Yes	Over pressure on cross jaws	Yes	Each operator had different parameter	Yes	Because visual control and counter lining regulator cross jaws were not existed yet (root cause 1)			
Answer											
Question	Failure on folding process	Timing first blow was unstable	Yes	Rubber roller was ready	Yes	Rubber roller with shaft had not locking yet (root cause 2)					
Answer											
Question	Failure on folding process	Because sachet did not folded in filling room	Yes	Because sachet jumped from conveyor into conveyor X-Ray	Yes	Because space between inside conveyor and conveyor X-Ray was so wide and also not straight and (root cause 3)					
Answer											
Question	Sachet stuck in drop plate	Because when sachet felt into drop plate, sachet became unstable (rocking)	Yes	Because there were only 2 fulcrum when sachet was down (root cause 4)							

3. Do

Researcher from cellular company gave statement that better communication and team work must be promoted to establish autonomous maintenance teams. Report archive was arranged by the time to prepare future data analysis [6].

TABLE VI
ACTION LIST FROM CAUSE ROOTS OF MINOR STOPPAGES IN FOLDING 1 AND 2 UNIT E

Root Causes	Action List	Who
RC 1	Reposition of regulator pressure cross jaws and visual control pressure	Ropikin
RC 2	Making a new roller design	Cosmas
RC 3	Closing gap between inside conveyor and conveyor X-Ray, also patenting both conveyor, then adding 2 roller of sachet justify	Afipudin
RC 4	Making a new design of drop plate	Cosmas

H. Minor Stoppages Report After Improvement From Go See Think Do

In Formation and Folding 1 & 2 Unit, the stakeholder had discussed the root causes and they were doing improvement. All progress was monitored to know success or not the action. If it was good perform so new standard was got and the company would do training and introduction to operator [7]. The action also was done in food industry as continuous improvement process [8]. This way aimed keeping result. In another hand, this chance did not work so other problems solving that more detailed used DMAIC (define, measure, analyse, improve, control) method. The evaluation was access every 10 weeks (from 32nd – 41st weeks) and it was served in Figure 11.

Figure 11 showed that significantly decreasing for index minor stoppages in SIC line 1. After improvement, score could reach lower capability, 77 index minor stoppages in 41th weeks. Based on 31st data, the problem leaked with 79,52%. It had indicated that the improvement from GSTD in Formation and Folding 1&2 Unit 2 was completed.

% minor stoppages that reduced

$$= \frac{\text{minor}_{\text{31th week}} - \text{minor}_{\text{1st week}}}{\text{minor}_{\text{31th week}}} \times 100\%$$

$$= \frac{(367 - 77)}{376} \times 100\%$$

$$= 79{,}52\%$$

The researcher used manual data collection. OEE could do compilation between daily and artificial report. Both of them were headed to company future (Maran et al., 2012). Implementation was a next step to improve productivity thorough production planning and maintenance procedure [4], [9].

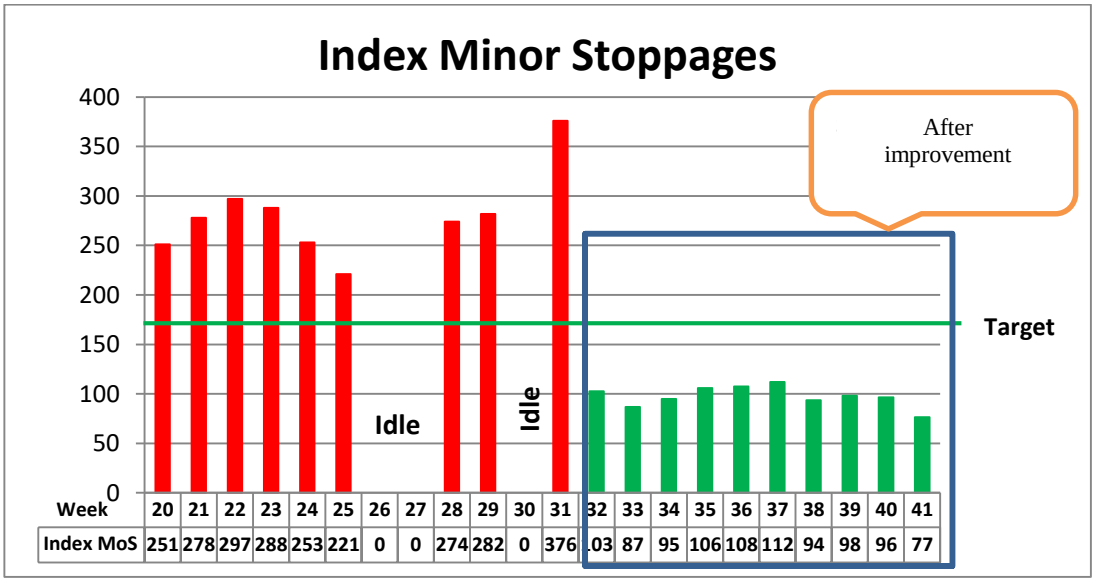

Figure 11. Index minor stoppages in SIC line 1 before and after improvement.

IV. CONCLUSION

Based on the description, the researcher had few main points such as conditions that giving the worst perform in SIC line 1. The experiment gave losses unplanned stoppages, minor stoppages. The bigger minor stoppages were sachet jammed in Formation and Folding 1&2 Unit. The detailed (for working of the autonomous maintenance) was founded in 31st weeks with 319 (64,60%) and 148 (29,72%) times in each series, then 519 as frequency total. Upgrading challenge that done to minimize the problems such as assembly center lining in separation unit 1 and 2, cover up of sensor holes in first product and reposition the sensor, modification gas slide guide from 12 to 5 mm, changing sensor from sensing dot to horizontal, reposition regulator pressure cross jaws and visual control pressure, implementation a new roller design completed with locked and a new drop plate design. Applications of autonomous maintenance to handle minor stoppage were routinely investigation of machine standard (lining, cleaning, and lubrication), GSTD as problem solving, quickly respond if it founded abnormality.

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